Powering the Future

Advanced Fuel Cycle research is an important complement to Generation IV development work at the Idaho National Laboratory.

Nuclear Programs

Generation IV Nuclear Technology

As the United States' lead laboratory for nuclear reactor research and development, INL will be at the epicenter of development for Gen IV nuclear reactor systems. Gen IV promises safe, economically competitive, proliferation-resistant nuclear power without the danger of increasing greenhouse gas emissions.

From the early beginnings of nuclear energy in the 1940s to the present, three generations of nuclear power reactors have been developed: early prototype reactors, commercial power reactors and advanced light water reactors. These three generations of nuclear energy systems have been successful in many ways. For example:

- Nuclear power accounts for 16 percent of global energy production. More than 435 reactors in 31 countries produce 356 billion watts of electricity without the emission of greenhouse gases.
- In the United States, nuclear energy provides 20 percent of the electricity –

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Lead bismuth is being tested in connection with the Lead-Cooled Fast reactor, one of six Gen IV reactor systems concepts.

Idaho National Laboratory

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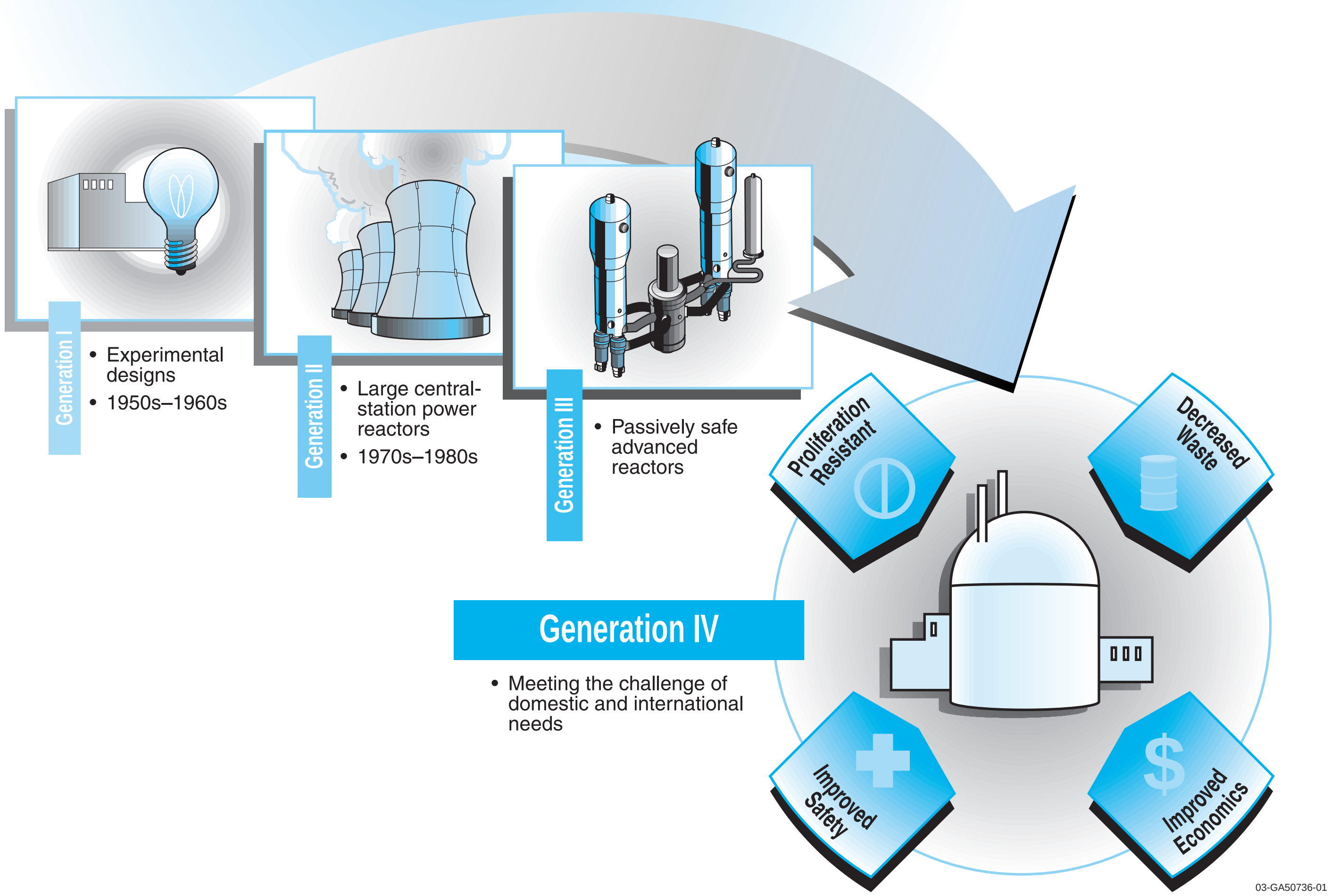
and improved efficiency in existing power plants over the past decade, has provided an increase in electrical power equivalent to building 20 new nuclear plants.

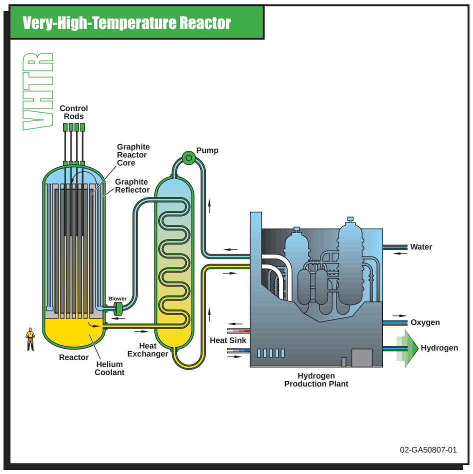
- Europe obtains 35 percent of its electricity from nuclear power – more than from any other source. The long-term use of nuclear power is an important part of the clean air and climate change prevention strategies in many European nations.
- Nuclear power is second only to hydropower for low-cost generation of electricity. In 2001, 103 nuclear plants in the U.S. had an average cost of 1.68 cents per kilowatt-hour.

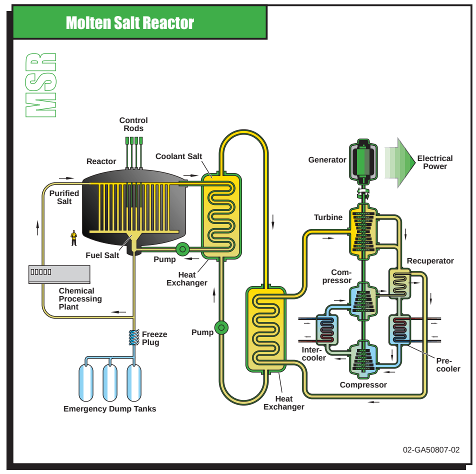
Challenges face the nuclear industry in the form of nuclear accidents at Three Mile Island and at Chernobyl, high capital costs of constructing new plants, and the need to establish final repositories for spent nuclear fuel. Proliferation of materials suitable for making nuclear weapons has also been a great concern.

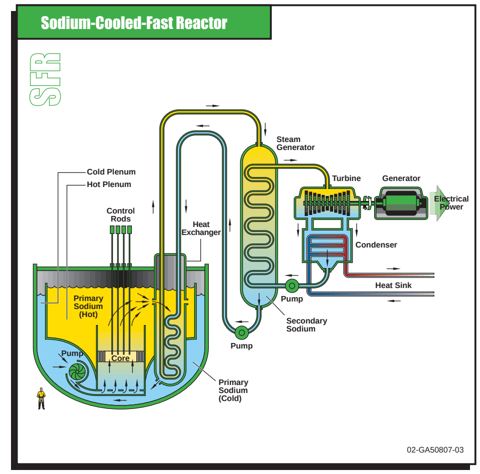
In spite of this, the nuclear energy industry has experienced economic and regulatory recovery in many parts of the world in recent years. For example, nearly all of the 103 commercial light water reactors in the U.S. are expected to file for 20-year license extensions. Thirty-five new reactors are under construction around the world. And nations that have not used nuclear-generated electricity before, have announced their intent to begin constructing new nuclear power plants. These things, and the fact that the world's population is expected to increase by

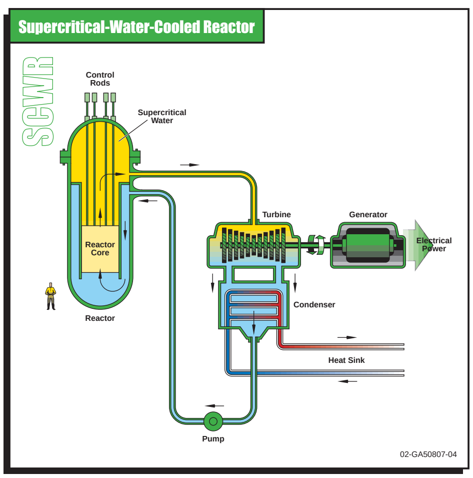
Nuclear power has developed in stages, or generations. We are currently in the third generation, researching technology for Generation IV.

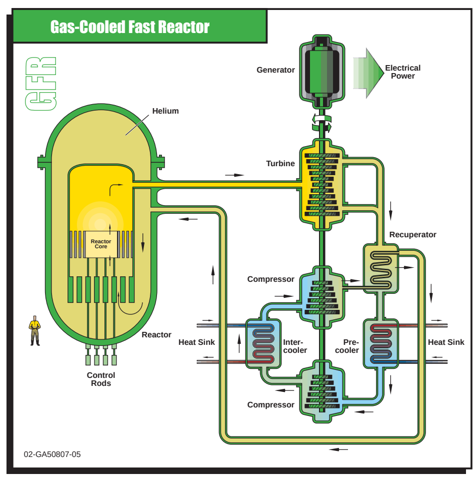


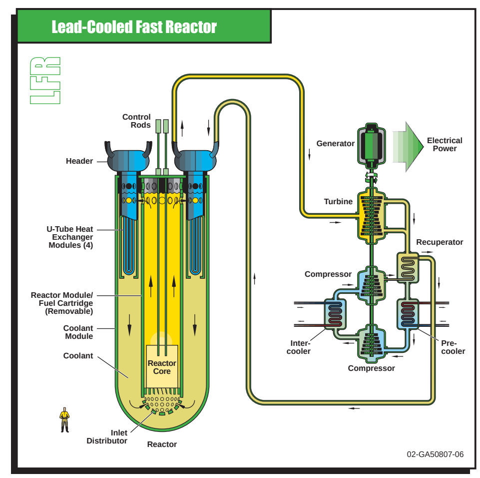












60 percent (from 6 billion to 10 billion) by the year 2050 – demonstrate that nuclear power has an important role to play in securing energy security and economic stability for the world. There is a profound need for a new generation of nuclear reactors. Gen IV will meet that need.

Eleven members have joined together in the Generation IV International Forum (GIF), agreeing on a framework for international cooperation in research. The goal is to develop future-generation nuclear energy systems that can be licensed, constructed, and operated in an economically competitive way while addressing the issues of safety, proliferation, and other public perception concerns. The object is for the Gen IV systems to be available for deployment by 2030.

Using more than 100 nuclear experts from its 10 member nations, the GIF has developed a Gen IV Technology Roadmap to guide the research and development of the world's most advanced, efficient and safe nuclear power systems. The Gen IV Technology Roadmap calls for extensive research and development of six different potential future reactor systems. These include water-cooled, gas-cooled, liquid metal-cooled and nonclassical systems. One or more of these reactor systems will provide the best combination of safety, reliability, efficiency and proliferation resistance at a competitive cost.

There are eight simple goals for the Gen IV Nuclear Energy Systems:

- Provide sustainable energy generation that meets clean air objectives and promotes long-term availability of systems and

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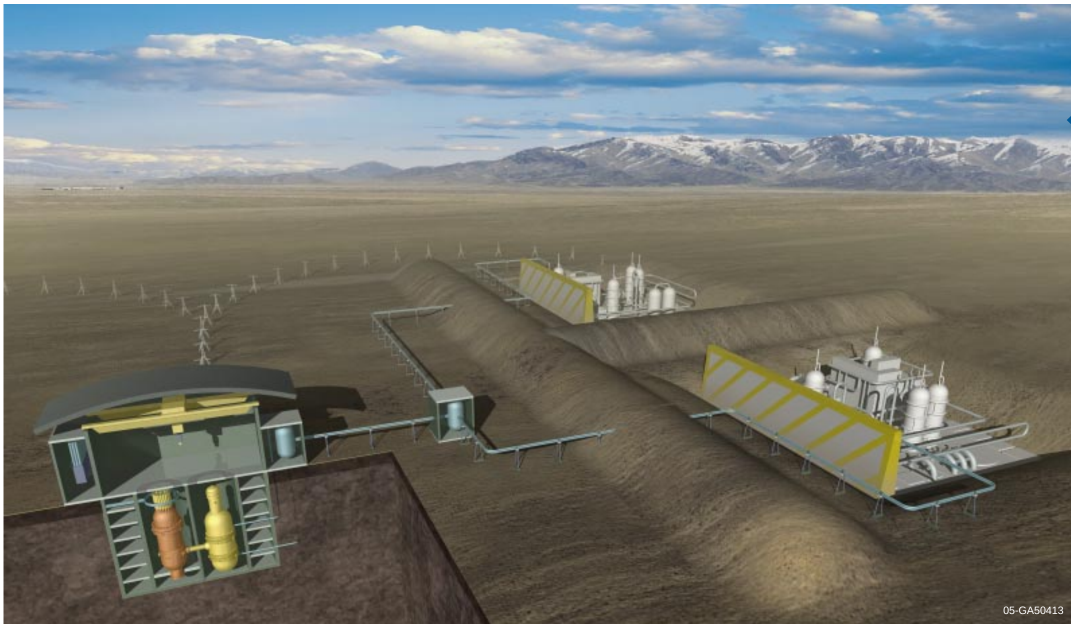
The figures above show the six technologies selected for further Generation IV nuclear power systems research.



The Very-High Temperature Reactor could produce both electricity and heat for hydrogen production.

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effective fuel use for worldwide energy production.

- Minimize and manage their nuclear waste and noticeably reduce the long-term stewardship burden in the future, improving the protection of public health and the environment.
- Have a clear life-cycle cost advantage over other energy sources.
- Have a level of financial risk comparable to other energy projects.
- Excel in safety and reliability.
- Have a low likelihood and degree of reactor core damage.
- Eliminate the need for off-site emergency response.
- Increase the assurance that these reactors are very unattractive and the least desirable route for diversion or theft of weapons-usable materials, and provide increased protection against acts of terrorism.

Generation IV at the INL

Idaho National Laboratory's (INL) Nuclear Programs organization is engaged in leading the nation toward successful development and deployment of Gen IV nuclear energy systems. Some 150 Nuclear Programs employees and more than 800 additional engineers and scientists use their specialties to execute all aspects of nuclear plant design, testing and operation.

Their expertise and the historic role of INL in developing America's nuclear reactor technologies go hand in hand. The 890 square mile INL Site was originally established in 1949 as the National Reactor Testing Station. For more than 50 years it has lived up to its original name.

Fifty-two nuclear reactors have been developed and built at the INL – including the first reactor to generate usable electricity and the U.S. Navy's first prototype nuclear propulsion plant. The INL is renowned for its ability to convert scientific ideas into actual operating equipment and to provide science and engineering solutions to complex nuclear safety, energy and security problems.

The nuclear power safety record in the United States relates directly to the years of fuel testing performed with Power Burst and Loss of Fluid Test programs, and the extensive INL analysis of fuel failures. Several unique facilities are currently in operation at the INL to support new reactor designs. These include the Advanced Test Reactor, Radiation Measurements and Thermophysical Materials Characterization Laboratories, the Remote Analytical Laboratory and fuel examination hot cells.

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